UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/616,163	07/09/2003	Kamal Kishore Goundar	ASMJP.135AUS	9751

20995 7590 07/27/2005

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
HARRISON, MONICA D	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 07/27/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/616,163	GOUNDAR, KAMAL KISHORE	
	Examiner	Art Unit	
	Monica D. Harrison	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 April 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2 and 4-27* is/are pending in the application.

4a) Of the above claim(s) *3* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1, 2, and 4-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 05/05
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Applicant's amendment filed 4/11/05 has been entered. Examiner acknowledges claim 3 has been cancelled and claims 23-27 have been added.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 2, and 4-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goundar et al (US 2004/0161535) in view of Xia et al (US 2002/0142578).

2. Regarding claim 1, Goundar et al discloses a method for depositing a nitrogen-doped silicon carbide layer onto a substrate, the method comprising: providing a silicon and carbon source gas comprising a non-alicyclic alkyl silicon compound, and an inert gas into a reaction zone, the reaction zone containing the substrate; producing an electric field in the reaction zone, the electric field generated using low and high frequency RF energy produced by an RF power supply, the RF power supply generating an average power at an electrode surface used for plasma discharge in the reaction zone; and reacting the silicon and carbon source gas and the nitrogen source gas to deposit on the substrate a nitrogen-doped silicon carbide film ; wherein the RF power supply generates high frequency RF power having a frequency between about 13 MHz and about 30 MHz and low frequency RF power having a frequency between about 100 kHz and about 500 kHz during a processing period, wherein a ratio of the low

frequency RF power to a total RF power is more than 0 but no more than about 0.15 (claims 1-4 and 19). However, Goundar et al does not disclose a nitrogen source gas comprising ammonia.

Xia et al discloses a nitrogen source gas comprising ammonia (pg.3, paragraph 0047).

Since Goundar et al and Xia et al are from the same field of endeavor, the purpose disclosed by Xia et al would have been recognized in the pertinent art of Goundar.

It is obvious, at the time the invention was made, for one with ordinary skill in the art, to modify Goundar et al with the teachings of Xia et al for the purpose of forming a low dielectric constant silicate material for use in integrated circuit fabrication processes.

3. Regarding claim 2, Goundar et al discloses wherein: the high frequency RF power has a power between about 200 watts and about 1000 watts; and the low frequency RF power has a power between about 50 watts and 500 watts (claim 2).

4. Regarding claim 4, Goundar et al discloses wherein the average power at the electrode surface is substantially constant (claim 5).

5. Regarding claim 5, Goundar et al discloses wherein the silicon and carbon source gas is one of the following: tri-methylsilane, tetra-methylsilane, or divinyl-dimethylsilane (claim 9).

6. Regarding claim 6, Goundar et al discloses wherein the inert gas is one of the following: helium, argon or krypton (claim 10).

7. Regarding claim 7, Goundar et al does not disclose a nitrogen source gas comprising ammonia. Xia et al discloses a nitrogen source gas comprising ammonia (pg.3, paragraph 0047).

Since Goundar et al and Xia et al are from the same field of endeavor, the purpose disclosed by Xia et al would have been recognized in the pertinent art of Goundar.

It is obvious, at the time the invention was made, for one with ordinary skill in the art, to modify Goundar et al with the teachings of Xia et al for the purpose of forming a low dielectric constant silicate material for use in integrated circuit fabrication processes.

8. Regarding claim 8, Goundar et al discloses wherein the ratio of the silicon and carbon source gas to the inert gas is between about 1:1 and about 1:15 (claim 11).

9. Regarding claim 9, Goundar et al discloses wherein the silicon and carbon source gas is provided into the reaction zone at a rate between about 200 sccm and about 500 sccm (claim 12).

10. Regarding claim 10, Goundar et al discloses wherein the substrate is heated to a temperature between about 200 degrees Celsius and about 400 degrees Celsius (claim 13).

11. Regarding claim 11, Goundar et al discloses wherein the substrate is heated to a temperature between about 320 degrees Celsius and about 350 degrees Celsius (claim 14).

12. Regarding claim 12, Goundar et al discloses wherein the reaction zone is maintained at a pressure between about 300 Pa and about 1000 Pa (claim 15).

13. Regarding claim 13, Goundar et al discloses wherein the reaction zone is maintained at a pressure between about 500 Pa and about 700 Pa (claim 16).

14. Regarding claim 14, Goundar et al discloses wherein the silicon carbide layer is nitrogen-doped, and wherein the nitrogen-doped silicon carbide layer has a dielectric constant less than about 5.0 (claim 19).

15. Regarding claim 15, Goundar et al wherein the silicon carbide layer has a compressive film stress of above 200 MPa (claim 20).

16. Regarding claims 16-22, Goundar et al does not disclose wherein the silicon carbide layer has a leakage current of less than 1x10-8A/ cm2 at an electric field of 1MV/cm (claim 16), wherein the film is an etch stop layer (claim 17), wherein the film is a hard mask (claim 18) the method for manufacturing on a semiconductor substrate an interlayer structure containing a film in contact with a copper layer, comprising the steps of: (i) forming multiple layers on a semiconductor substrate; (ii) forming a hole for an interlayer connection of the multiple layers by etching; (iii) depositing copper in the hole; (iv) removing an excess of the copper from a top of the multiple layers; (v) depositing a nitrogen-doped silicon carbide film on the top of the multiple layers by the method of Claim 1, wherein the copper is covered by the silicon carbide film (claim 19), wherein the multiple layers comprise a lower etch stop layer, a lower low dielectric layer, an intermediate etch stop layer, an upper low dielectric layer, and in step (ii) an upper etch stop layer laminated in sequence on the substrate, and the hole is produced by forming a resist on top of the upper etch stop layer and forming a via hole and trench by etching the multiple layers using the resist, and in step (iv) the resist and the upper etch stop layer are removed when removing the excess of the copper (claim 20), a low dielectric layer is formed on the substrate, and the multiple layers are formed on top of the low dielectric layer (claim 21) and wherein steps (i) through (iv) are repeated at least once (claim 22).

Xia et al discloses wherein the silicon carbide layer has a leakage current of less than 1x10-8A/ cm2 at an electric field of 1MV/cm (column 9, lines 37-67 thru column 10, lines 1-31), wherein the film is an etch stop layer (Figure D, reference 411) and wherein the film is a

hard mask (Figure 4D, reference 411; pg.5, paragraph 0065), a method for manufacturing on a semiconductor substrate an interlayer structure containing a film in contact with a copper layer, comprising the steps of: (i) forming multiple layers on a semiconductor substrate (Figures 4A-4J); (ii) forming a hole for an interlayer connection of the multiple layers by etching (Figure 4H, reference 407); (iii) depositing copper in the hole (Figure 4J, reference 416); (iv) removing an excess of the copper from a top of the multiple layers (pg.5, paragraph 0072); (v) depositing a nitrogen-doped silicon carbide film on the top of the multiple layers by the method of Claim 1, wherein the copper is covered by the silicon carbide film (Figure 4H, reference 409), wherein the multiple layers comprise a lower etch stop layer (Figure 4J, reference 403), a lower low dielectric layer (Figure 4J, reference 405), an intermediate etch stop layer (Figure 4J, reference 406), an upper low dielectric layer (Figure 4J, reference 408), and in step (ii) an upper etch stop layer laminated in sequence on the substrate (Figure 4J), and the hole is produced by forming a resist on top of the upper etch stop layer (Figure 4H, reference 407) and forming a via hole and trench by etching the multiple layers using the resist (Figure 41), and in step (iv) the resist and the upper etch stop layer are removed when removing the excess of the copper (Figure 4J), wherein prior to step (i), a low dielectric layer is formed on the substrate (Figure 4C, reference 403) and the multiple layers are formed on top of the low dielectric layer (Figure 4C), and wherein steps (i) through (iv) are repeated at least once (Figures 4A-4J).

Since Goundar et al and Xia et al are from the same field of endeavor, the purpose disclosed by Xia et al would have been recognized in the pertinent art of Goundar et al.

It would have been obvious, at the time the invention was made, for one with ordinary skill in the art, to modify Goundar et al with the teachings of Xia et al for the purpose of providing a method of depositing low K barrier layers.

17. Regarding claims 23-25, Goundar et al discloses a method for depositing a nitrogen-doped silicon carbide layer onto a substrate, the method comprising: an inert gas into a reaction zone containing the substrate therein, wherein a flow ratio of the non-alicyclic alkyl silicon compound to the inert gas is between about 1:1 and about 1:15 (claim 13); producing an electric field in the reaction zone, the electric field generated using low and high frequency R.F energy produced by an RF power supply, the RF power supply generating an average power at an electrode surface used for plasma discharge in the reaction zone; and reacting the silicon and carbon source gas and the nitrogen source gas to deposit on the substrate a nitrogen-doped silicon carbide film (claim 19); wherein the RF power supply generates high frequency RF power having a frequency between about 13 MHZ and about 30 MHZ and low frequency RF power having a frequency between about 100 kHz and about 500 kHz during a processing period, wherein a ratio of the low frequency RF power to a total RF power is more than 0 but no more than about 0.15 (claims 1-4). However, Goundar et al does not introduce a non-alicyclic alkyl silicon compound and ammonia (claim 23), wherein a flow rate of the non-alicyclic alkyl silicon compound is 100-500 sccm, a flow rate of the ammonia is 50-500 sccm, and a flow rate of the inert gas (claim 24), wherein the ammonia is the sole source of nitrogen (claim 25).

Xia et al discloses a non-alicyclic alkyl silicon compound and ammonia (pg.3, paragraphs 0046-0047) wherein a flow rate of the non-alicyclic alkyl silicon compound is 100-500 sccm, a

flow rate of the ammonia is 50-500 sccm, and a flow rate of the inert gas (pg.3, paragraphs 0044-0049), wherein the ammonia is the sole source of nitrogen (pg.3, paragraph 0047).

Since Goundar et al and Xia et al are from the same field of endeavor, the purpose disclosed by Xia et al would have been recognized in the pertinent art of Goundar et al.

It is obvious, at the time the invention was made, for one with ordinary skill in the art, to modify Goundar et al with the teachings of Xia et al for the purpose of forming a low dielectric constant silicate material for use in integrated circuit fabrication processes

18. Regarding claim 26, Goundar et al discloses wherein the silicon carbide layer has a compressive film stress of above 200 MPa and a leakage current of less than 1x10-8A/ 2 at an electric field cm a of 1MV/cm (claim 20)

19. Regarding claim 27, Goundar et al discloses wherein the silicon carbide layer has a dielectric constant of 4.5 to 5.0 (claims 17 and 18).

Double Patenting

20. Claims 1-2 and 4-27 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-20 of copending Application No. 10/414467. Although the conflicting claims are not identical, they are not patentably distinct from each other because application 10/414467 does not claim ammonia or a nitrogen source.

This is a provisional obviousness-type double patenting rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Monica D. Harrison whose telephone number is 571-272-1959. The examiner can normally be reached on M-F 7:00am-3:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Monica D. Harrison
AU 2813

mdh
July 6, 2005

CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800